Application of Multi-Shaft Deep Mixing for Seismic Remediation of Earth Dams – Historical Review from Jackson Lake Dam to Perris Lake Dam

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Abstract

The deep mixing (DM) method mixes in situ soils with cement to produce soil-cement columns using a single-shaft mixing tool, or panel elements using multi-shaft mixing tool. The soil-cement columns or panel elements have higher strength and lower compressibility than the existing soils and are utilized to maintain ground stability and to control ground movement under loads induced by new construction or seismic event. The use of deep mixing for seismic mitigation includes reinforcement of liquefiable soil and reduction of excessive pore pressure. Reinforcement of liquefiable soils is accomplished by installing soil-cement walls in block, wall, or cell configurations to resist the loads from embankments or other upper structures. The reinforced ground, including the treated soil and untreated soil, would become more rigid and the untreated soil would experience less cyclic strain, which in turn could reduce the generation of excessive pore water pressure and consequently lower the liquefaction potential.

In the United States, the first major application of contemporary deep mixing method was the improvement of the foundation of Jackson Lake Dam, Wyoming in 1988. Since then deep mixing was used for seismic remediation of Clemson Upper and Lower Diversion Dams, South Carolina in 2005; remediation of Sunset North Basin Dam, California in 2006; seismic upgrades of San Pablo Dam, California in 2009 and seismic remediation of Perris Dam in 2016. This presentation will 1) provide the background of deep mixing method and the research and application of deep mixing for seismic mitigation and 2) present the design, construction and quality control of deep mixing for seismic remediation of these five earth dams in the U.S.